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STUDY OF A PEAT BOG NEAR THE MATAMEK RIVER, QUEBEC, CANADA, BY THE METHOD OF POLLEN ANALYSIS

BY

PAUL W. BOWMAN

L. C.

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STUDY OF A PEAT BOG NEAR THE MATAMEK RIVER, QUEBEC, CANADA, BY THE METHOD OF POLLEN ANALYSIS

Paul W. Bowman

The George Washington University

Purpose

It is the purpose of this paper to trace the history of the vegetation of a bog located in the Province of Quebec, Canada, on the " North Shore," about 15 miles northeast of the mouth of the Moisie River by the method of pollen analysis.

Historic Background

According to Erdtman ('27) the idea of gathering information from the study of fossil pollen originated with G. Lagerheim, at the University of Stockholm, during the first decade of this century. The working methods were developed by L. von Post, at the Geological Survey of Sweden, and are described by Erdtman ('21) in another paper.

Extensive studies have been made of the bogs of northern Europe by this method, and much has been learned about the history of the forests and their migration after the recession of the ice sheet.

Little work of this kind has been done thus far in America. Auer ('27) made a study of a series of bogs in southeastern Canada. Lewis and Cocke ('29) worked on peat from the Dismal Swamp of Virginia and North Carolina. Draper ('29) and Sears ('30*b*) studied some Ohio bogs. Interest in this field is increasing rapidly, and we expect to see many papers on pollen analysis published in the next few years.

Climate and Vegetation

The growing season in the Matamek River district is very short. In 1927 the alders, *Alnus crispa,*[1] shed their pollen about the 20th of June, and the conifers, mostly *Pinus Banksiana, Picea mariana, P. canadensis* and *Abies balsamea,* shed theirs about the 4th of July. It is reported that the first freeze usually occurs during the first week in September. The rocks and soil exposed to the sun in midsummer become hot, but the water of the Gulf of St. Lawrence, and of the streams emptying into it, is very cold. Marie-Victorin ('27, p. 84) says that ice sometimes persists throughout the year

[1] Botanical names, unless otherwise indicated, are those of the seventh edition of Gray's Manual.

deep in soil which is shaded by dense spruce (*Picea* spp.) forests, and we believe this to have been the reason for our inability to penetrate to the bottom of this peat deposit at several points.

The principal forest trees of this district are the spruces, *Picea canadensis* and *P. mariana,* mixed with some fir, *Abies balsamea,* and an occasional large birch, *Betula alba.* Willows, *Salix* spp., and birches are common along the banks of streams. *Pinus Banksiana* was seen in open formation on a dry sandy plain. Alder is common in open moist places. For a more detailed study of the flora of the "North Shore" see St. John ('22), and for further observations on that of the Matamek River district see Bowman (awaiting publication).

Age of Bog and Present Cover

Coleman ('13) estimates that about 25,000 years have elapsed since the spot on which the city of Montreal now stands was uncovered by the receding ice sheet. The Matamek River district is about 500 miles northeast of Montreal, and probably did not emerge until some time later.

According to Hind (1864), the old shoreline which was uncovered by the last glacier has since risen about 1,000 feet and is now some miles inland. This bog rests upon a floor of fine gray sand and clay which is approximately 100 feet above the present sea level.

Since this elevation is about one-tenth of the total rise which appears to have taken place in the last 25,000 years or less, we may estimate the greatest possible age of this bog to be under 2,500 years. The presence of terraces suggests that the land did not rise at a constant rate during this time.

The bog is now covered with an old forest of spruce and fir, under which scattered patches of *Sphagnum* may be found. It is interesting to compare the findings in this bog with those obtained by Auer ('27) in bogs farther south, as this bog is above the northern limits of many of the plants found in the flora of the ones he studied, and is probably much younger.

Methods

Cores were collected with a Davis peat sampler (Bastin and Davis, '09). This consists essentially of a brass tube containing a pointed plunger (Fig. 1),

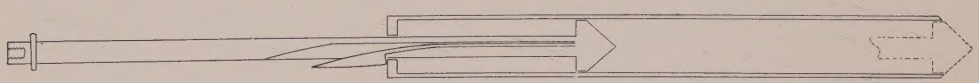

Fig. 1. Davis peat sampler; median longitudinal section.

and brings up a cylinder of peat about ¾ inch in diameter and 6 inches long from any desired depth up to the length of the instrument. The handle by

means of which it was pushed down and withdrawn is made of "eighth-inch" iron pipe, which is about 3/8 inch in outside diameter. This is cut into 2-foot lengths, which are easy to carry and which provide a convenient means of measuring depth, and is surmounted by a cross-piece by means of which to grasp it. In operation the sampler is pushed down to the depth from which it is desired to take a core, and the handle is drawn up gently until the plunger head reaches the top of the tube where it is held by a spring catch. The sampler is then pushed down 6 inches farther, the sharp edges of the tube cutting out a core of peat which fills it. The whole is withdrawn and the spring catch pressed into its slot to release the plunger head which is used as a piston to eject the sample upon a piece of paper.

The cores were rolled up in sheets of newspaper, which is rather absorbent, and labeled as to depth, for example, 5 to 5.5 feet, and as to orientation, that is, which end had been uppermost. We found that labels written on the wrapper with soft black pencil were quite satisfactory, since, although they were obscured by wetting, they became clearly visible again when the paper dried out. It is desirable to spread the rolls in a well-aired place until they are quite dry in order to prevent the growth of molds.

In order to prevent mixing of samples from different depths, successive ones were not taken from the same hole.

To prepare the peat for study, the end of a cylinder was carefully scraped in order to remove any foreign matter which may have adhered to the surface. The upper end was used because the depth of that portion was known. The peat at the lower end of the cylinder may have come from a point 6 *or more* inches below that at the upper end, according to its compactness and the extent to which it had been compressed in the tube. About a cubic centimeter was cut off, broken up in a beaker, covered with about 25 c.c. of 10 per cent solution of potassium hydroxide, and boiled for 3 to 5 minutes in order thoroughly to separate the particles of which it was composed. This mixture was strained through cheesecloth to remove the larger objects, and then centrifuged to separate the peat from the liquid. The sediment was washed with water to remove most of the potassium hydroxide solution, and then shaken up in 10 c.c. of water to which was added 5 drops of 1 per cent aqueous solution of gentian violet. It was allowed to stain in this for about 10 minutes. The violet not only makes the spores rather easy to see, but colors some elements in the peat differently, for instance, birch spores usually appear red and certain egg cases (?) blue. The stained material was then passed quickly through 95 per cent alcohol, absolute alcohol (100 per cent), and xylol, after which it was stirred up in several drops of Canada balsam and distributed over about 10 slides, to which were applied 22 × 40 mm. cover slips.

We have since found that very satisfactory results may be obtained by staining with an aqueous solution of safranin which is added to the potassium

hydroxide solution in which the peat is boiled. This eliminates one step in the process of preparation, and gives a more uniform stain than the violet.

These samples were then studied with the aid of a mechanical stage. After each trip across the slide horizontally the stage was advanced 1 m.m., which left an unobserved area between each pair of bands in which the spores were counted, and thus avoided counting the same ones twice, because the diameter of the field was less than 1 m.m. For these observations a 4 mm., objective and 15-x oculars were used. At the start of each transit of the slide the reading of the vertical scale of the mechanical stage was recorded, with an arrow by its side to indicate the apparent direction in which objects in the field were to be moved. Such a device permits one to continue after interruptions without danger of duplicate counting.

We now use an 8 m.m. objective. Because of its greater working distance this lens is less likely to come in contact with the cover glass, which happens with the 4 m.m. objective when the sample on the slide is a bit thick. Its larger field permits one to count more spores in a single transit of the slide. The greater depth of focus makes the field easier to look at, and reduces eye strain.

A camera-lucida was kept in position while observations were being made, so that as objects of interest were found they could be drawn accurately for future study, and so that the image of an unknown specimen could be superimposed upon a drawing of a known one and directly compared with it.

Identification of unknown pollens is based for the most part on comparisons with material the identity of which is known. Slides are made of fresh pollen during the summer as plants are collected. When fresh material is not available, pollen is obtained by boiling anthers from dried specimens. A number of collections of each kind should be made from different sources and compared in order to avoid errors in identification, as the spores of *Betula* are sometimes formed with 4 pores instead of 3, and capsules of *Sphagnum,* instead of containing the usual angular spores, may be filled with the spherical ones of *Tilletia sphagni* (Nawaschin, 1890).

Some of the first papers published on the identification of pollen dealt with the subject from the standpoint of the bee-keeper (Betts, '25 and Young, '08). The study of pollens as a cause of hay-fever has brought out more literature. In these fields the interest lies in fresh material, and the nature of the stored food as well as the date of shedding are used as aids in identification (Scheppegrell, '22, and Moore and LaGarde, '26). In the study of fossil pollens one must depend entirely upon the characteristics of the wall, such as size, shape, number of pores and grooves, and nature of the sculpturing if any. The drawings published by Meinke ('27) are rather helpful, as are also those of Lewis and Cocke ('29) and Sears ('30*a*). The classic work of von Mohl (1835), although it deals with few of the genera usually found in peat, is of considerable interest in that it indicates clearly the different appearances which may be presented by the same pollen-grain

according to the angle from which it is viewed, or whether it be shrunken or expanded. Pope ('25) and Wodehouse ('26 and '28) have written on pollen morphology as an index to plant relationship.

The point to which the identification of a pollen-grain can be carried varies greatly according to its family. The pollens of grasses (Gramineae) and sedges (Cyperaceae) are recognizable as such, but we are not yet able clearly to identify genera. Those of fir, spruce and pine can usually be separated on the basis of size, but some overlapping of the size ranges occurs, and they must then be distinguished by differences in form. Chemical treatment may bring out variations in structure not otherwise evident (Jentys-Szafer, '28). The spores of various species of *Lycopodium* differ considerably. A thorough and systematic treatment of different groups of spores which would include information as to the variation in size and form, and a good picture of an average spore of each species, would be a great help to those engaged in pollen analysis.

There are different opinions on the question of how many spores to count in order to obtain reliable figures on the relative density of the different kinds present. Lewis and Cocke ('29, p. 40) say: "In counting the different pollens for reckoning the percentage of any given species, 800 grains were counted from each depth." Sears ('30*b*, p. 210) says: "At least 2 slides were prepared from each sample. . . . Wherever possible, at least 100 grains were counted from each slide." Erdtman ('31, p. 400) says: "Trustworthy percentages are obtained if about 150 pollen-grains are counted." The results shown in this paper are based on counts of 1,000 to 1,800. The problem of interpretation of results is further complicated by the fact that some authors include in their count the spores of Bryophytes and Pteridophytes, whereas others include only "forest trees." Until some uniform procedure which will make published results comparable is agreed upon it is strongly recommended that a clear statement as to how the percentages were calculated be included in each paper.

The following observations were made to indicate the degree of error which may be expected from counts of various numbers of spores. In Table

TABLE I. *Number of each kind of spore found per hundred for twenty different hundreds, all from one sample on one slide*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Av.*	Total
Betula	29	31	25	18	19	25	19	31	28	26	20	33	19	21	26	25	24	27	31	28	25.1	505
Sphagnum	16	18	20	28	27	24	22	19	15	21	26	15	23	20	25	21	22	19	20	27	21.4	428
Sedge	18	18	14	22	17	17	21	20	16	21	20	17	12	20	23	20	19	20	22	19	18.8	376
Picea	8	9	12	16	21	7	13	11	16	14	16	12	20	13	11	8	14	13	12	10	12.8	256
Alnus	10	16	14	5	4	7	5	9	7	4	5	3	6	10	7	5	2	5	3	3	6.5	130
Abies	5	2	2	1	4	7	11	3	7	8	5	12	6	3	4	10	9	7	6	3	5.8	115
Pinus	1	3	3	3	4	3	5	2	3	1	2	0	5	2	2	0	0	6	3	2	2.5	50
Ericaceae	1	0	2	2	0	1	1	1	3	0	1	2	1	1	0	1	0	0	0	2	1.0	19
Ferns	3	1	1	0	0	3	0	2	0	0	1	1	1	1	0	1	1	0	0	0	0.8	16
Lycopodium	0	0	0	1	2	0	0	0	2	0	0	0	1	1	1	1	0	0	0	1	0.5	10
Others	9	2	7	4	2	6	3	2	3	5	4	5	6	8	1	8	9	3	3	5		

* Average based on total count of two thousand.

I is shown the percentage of each kind of spore identified in 20 different counts of 100 each, taken from a single slide, and recorded in the order in which they were made. The sample was thoroughly mixed and spread before the cover glass was applied. Note especially the fourth, sixth and twelfth hundreds. Fig. 2 shows graphically the averages obtained from the

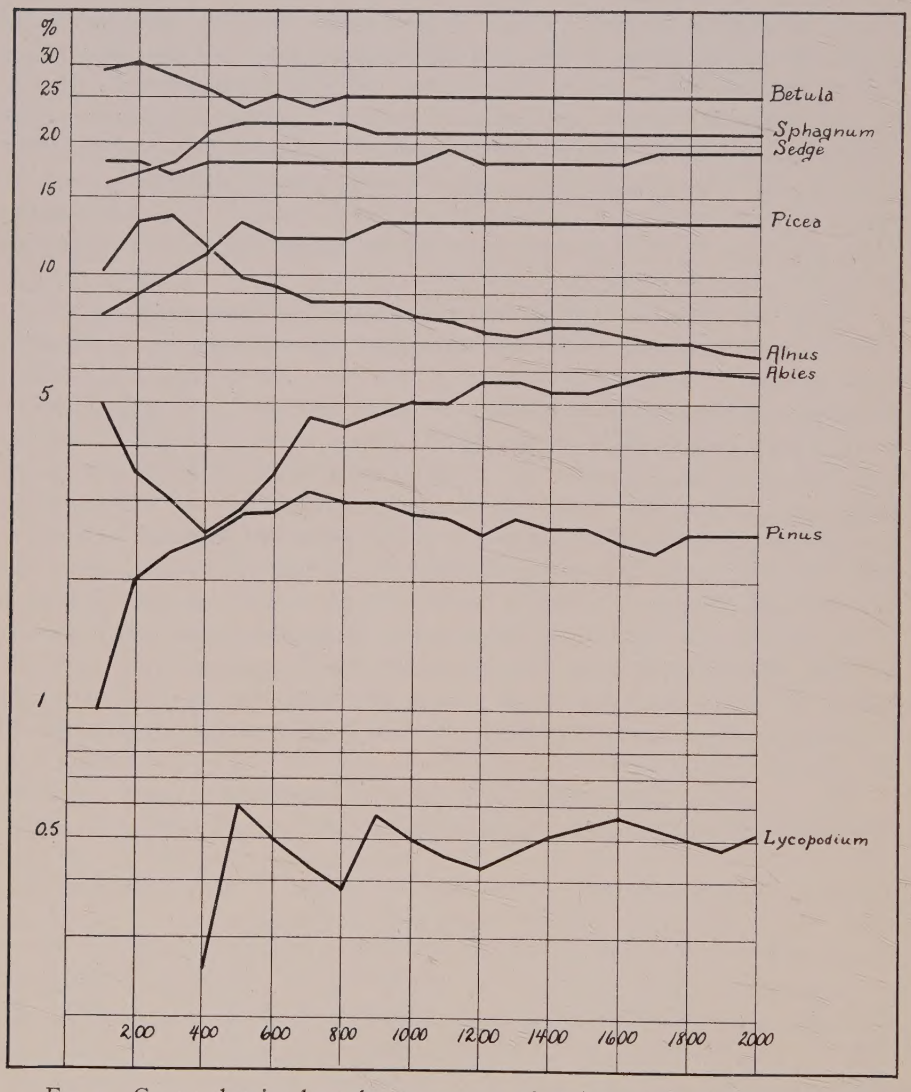

FIG. 2. Curves showing how the percentages of various kinds of spores counted in one sample on one slide vary as the number of spores counted is increased.

first hundred, the first two hundred, the first three hundred, and so on, the last values representing the averages obtained from the entire twenty hun-

dred. The percentages are drawn on a logarithmic scale so that the variations shown are comparable in degree.

Marked differences have been noted in the concentration of spores, that is, the total number per cubic centimeter of peat, at different levels (Auer, '27). Malmström ('23, pp. 198–199) observes that the concentration is greatest in sedge peat (Cyperaceentorf). Our findings are in accord with this statement. Not only is the concentration in the lower half of the deposit, where sedge is found, greater than in the upper half, but in general the points of greatest concentration coincide with maxima in the sedge curve. The figures showing relative concentration are presented in Table II. It seems that a certain amount of concentration is to be expected in the lower levels, because disintegrating influences have had longer to operate on that material and because it is compressed by the weight of the peat above it.

The record of different kinds of spores observed, and the percentage of each at each level, is given in condensed form in Table II. Interpretation of such records is usually based on the assumption that windblown pollens are uniformly distributed, which appears to be true for small areas. When one tries to form a picture of the flora as it existed at some time in the past from a count of fossil pollen-grains it must be kept in mind that a certain group of spores may have come from a few plants nearby or from many plants at a distance, and also that some pollen-grains are more delicate than others and seem not to be preserved in peat, for instance, *Chamaecyparis* and *Taxodium* (Lewis, '29, p. 41), *Juniperus* and *Thuja* (Sears, '30*a*, p. 101), and *Populus* (Erdtman, '31, p. 401). In spite of these limitations, the evidence of pollen-analysis is valuable in interpreting plant history, for the presence of certain forms and the changes which took place in the relative quantities of these can be definitely established.

Analysis

The problem is from the counts at all levels to construct frequency curves for all kinds of pollen found, and to interpret these in terms of dominance and succession. It is desired also from such studies to draw conclusions as to the nature of climatic changes which have taken place in the past, but this cannot be done until a great many observations shall have been made over a large area, so that nonsignificant variations due to local conditions may be eliminated.

The frequency curves (see Figs. 3 to 6), which are based on per cent of total spores exclusive of fungi, show how various elements in the flora of this bog rose to a position of dominance and then declined. These will now be discussed in detail.

Let us consider first the curve of spruce, *Picea spp.* (Fig. 3), as it is one of the elements of major importance. Its general trend is upward to its present position of dominance, but its advance is by a series of oscillations in the course of which it presents 6 maxima.

TABLE II. *Percentage of various spores at each level*

Depth in ft.	*Picea*	*Betula*	*Pinus*	*Abies*	*Alnus*	Ericaceae	*Lycopodium*	Ferns	*Sphagnum*	*Salix*	*Compositae*	Sedge	*Acer*	*Tsuga*	Gramineae	Fungi			Diatoms	Unknowns	*Density of spores	Number of spores counted
																A	B	C				
0	42.6%	13.7%	7.7%	14.3%	1.3%	2.8%	0.7%	0.2%	5.3%	0.2%	0.9%	0.7%	0.1%		4.5%	0.3%	0.3%		0.5%	4.6%	600	1073
½	53.6	5.7	5.7	15.3	0.3	2.2	0.8		13.6		0.1					0.1			0.1	2.7	410	1025
1	36.5	4.8	2.7	9.5		0.3	0.4	0.5	39.6				0.1			3.6			0.4	2.0	260	1024
2	23.6	30.0	5.0	3.6	1.2	3.0	0.4	0.2	25.2	0.1						1.9	5.0		0.4	5.1	590	1000
2½	8.1	6.4	1.0	1.1	0.1	0.1	0.1	0.1	80.3							1.2	1.0		0.4	1.4	1250	1475
3	25.7	6.2	2.4	4.2	0.5	0.8	0.1	0.2	55.9				0.1		0.2	1.8	2.2	0.1%	0.3	1.7	1300	1305
3½	38.5	13.7	2.9	7.5	0.3	1.0	0.1	0.3	31.9	1.6						36.0			0.1	1,3	1360	1364
4	26.9	13.8	1.5	4.7	0.5	4.3	0.7	0.3	43.9	0.3						0.9	2.9		0.3	1.7	1620	1706
4½	20.8	14.3	1.7	3.0	0.5	2.7	0.1	0.1	54.9		0.1				0.1	0.9	0.7		0.3	0.9	1880	1877
5	32.8	5.9	2.8	4.4	0.2	1.6	0.2	0.1	48.2	0.2						0.8	1.2			1.6	4250	1276
5½	16.9	25.1	0.8	2.6	0.4	1.6	0.7	0.2	36.3	0.6	0.1	9.1	0.1	0.2%	0.1	2.1	2.6		0.2	2.5	9400	1880
6	12.2	12.0	0.4	3.0	0.4	0.2	0.5	0.4	59.6	0.2		3.9	0.3	0.2		1.4	20.2		0.3	4.8	2880	1008
6½	20.3	21.0	2.0	1.7	0.7	0.9	0.9	0.5	37.1	0.2	0.1	10.1	0.8	0.1		2.1	1.7		0.5	1.3	6320	1264
7	16.0	21.3	2.2	31.0	6.6	0.1	3.3	0.8	3.7	0.2	0.2	9.3	1.8	0.3		0.1	5.1	0.1	0.5	3.0	770	1000
7½	19.9	22.3	2.4	5.9	1.2	0.7	1.5	0.4	33.7	0.5		8.4	0.1			1.4	10.0	0.2	0.2	1.7	2540	1016
8	11.1	15.5	1.9	14.7	5.6	0.6	0.4	0.5	42.5	0.2	0.1	3.5	0.2	0.1			0.3	0.1		3.0	3710	1112
8½	12.2	29.1	1.1	9.3	4.4	0.2	1.0	0.8	24.2	0.1		12.0	0.7	0.1		1.7	5.5	0.3		3.0	1980	1000
9	27.3	15.3	2.1	33.0	5.2	0.7	1.2	0.7	4.6			7.5	0.3			0.3	0.5	1.8		1.8	950	1000
9½	9.9	24.2	2.2	5.2	4.4	0.4	1.6	0.1	28.3	0.5	0.2	16.4				1.3	4.9	0.5	0.3	3.9	1540	1000
10	14.4	24.2	1.9	4.3	8.7	0.6	0.1	0.5	23.7		0.1	16.4				1.2	6.7	0.8		3.1	2000	1000
10½	15.5	24.2	1.5	4.6	4.1	0.5	1.1	0.5	30.8	0.1	0.4	10.1	0.3			1.2	11.4	0.4		5.2	1430	1001
11	14.9	25.5	1.2	5.5	5.4	1.4	1.0	0.9	28.3	0.2	0.2	9.4	0.3	0.2		2.5	6.9	0.2	0.2	3.0	3330	1000
11¼	7.1	10.0	0.9	3.6	1.4	0.1	0.1	0.3	1.6	0.1	0.1	71.9	0.2			0.2	0.3	0.1	0.4	2.2	5000	1043

† These percentages are based on the total of all spores listed except fungi.
* Relative density of spores in different samples is indicated by the approximate number counted in twenty transits of a slide.

The curve of birch, *Betula,* shows a general downward tendency upon which has been imposed the same set of secondary fluctuations.

Further study of these curves shows that they cross at about the 5½ foot level, below which birch was most abundant and above which spruce is dominant.

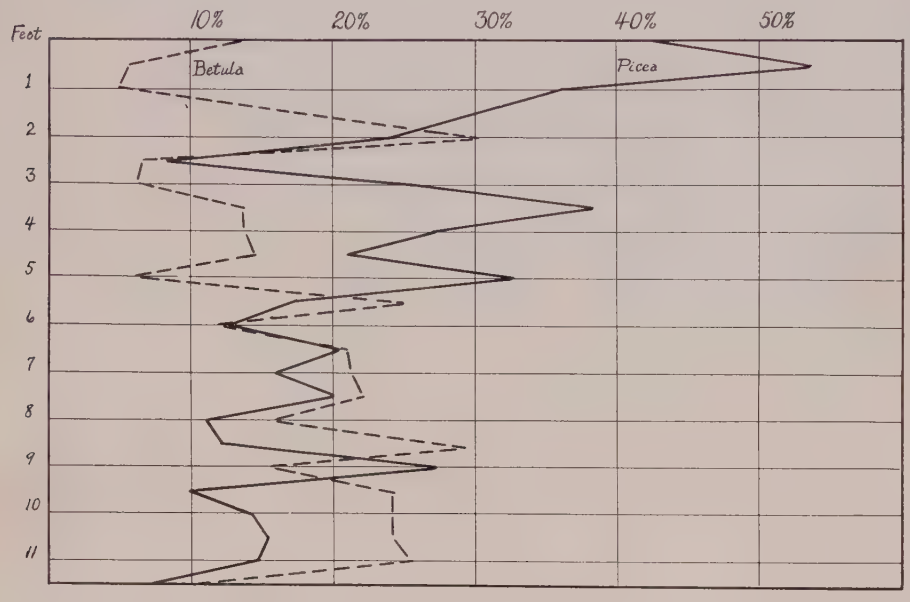

FIG. 3. Curves of *Betula* and *Picea.*

The corresponding maxima and minima of the spruce and birch curves do not always occur at the same depth. Below 5½ feet spruce seems to respond more quickly to the causes of these secondary variations whatever they may have been, than birch. Above this level the reverse is true. For example, a spruce peak occurs at 9 feet and the corresponding birch peak is seen at 8½, whereas the spruce peak at 5 feet has its corresponding birch peak at 5½.

These points focus our attention upon the 5½-foot level which we find to be of peculiar interest because it seems to mark the end of a period during which this area was being invaded by trees, and the beginning of one during which the entire area was covered with trees.

The main point in support of this conclusion is the presence of sedge pollen, Cyperaceae, in decreasing but appreciable quantities up to this level, and its absence beyond, except for an insignificant bit at the surface (see Fig. 4). If we consider that a relatively enormous quantity of pollen is shed by any one of the trees found here, especially the conifers, Pinaceae, as compared to that shed by a stand of sedge covering the same area, and that sedge does not ordinarily grow in the forest under trees, but rather out in

the light, the picture representing this stage of development must be one of a great open swamp over which are scattered small groups of trees, growing probably on the higher and dryer spots.

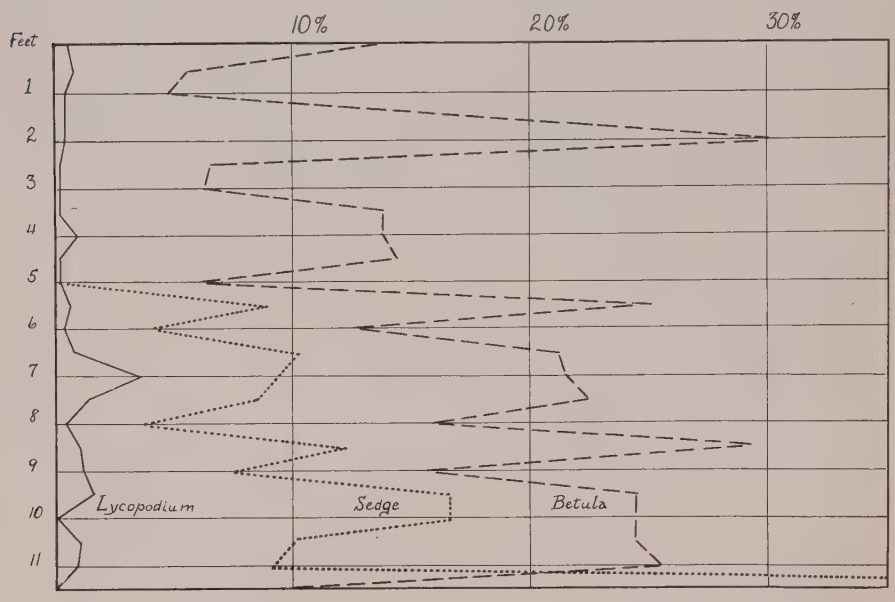

FIG. 4. Curves of *Betula*, Sedge and *Lycopodium*.

In the upper levels of the peat the spores of certain forms, Compositae, Cyperaceae, *Acer, Tsuga, Abies, Alnus, Lycopodium* and Filicales (see Table II and Figs. 4 and 5), are absent or decidedly reduced in quantity. Such a change could have been brought about by increased shade (Nichols, '15, p. 209) and by increased competition and it, also, suggests that the growth over this bog in its later stages of development was a closed forest.

These findings support Auer ('27) in his contention that the flora of the earlier period of the bogs of this region was richer in genera than that which formed the upper layers. This point is most clearly illustrated in Table II, in which is listed the percentage of each kind of spore found at each level.

The origin of this deposit as a sedge swamp growing on a foundation of glacial till, and its later development by increased growth of *Sphagnum* and decline and disappearance of the sedge (see Fig. 5), are in agreement with Auer's statement ('27, p. 14) that in the ocean area, as contrasted with the continental or inland area, peat bogs usually arise on dry land or on land recently exposed by recession of the shoreline, and consist of a thin lower stratum of *Carex* covered with a thick deposit of *Sphagnum* (p. 9).

The *Sphagnum* maximum occurs at 2½ feet and exceeds 80 per cent. There is, generally speaking, a peak in the *Sphagnum* curve corresponding

to each major depression in the spruce curve (see Fig. 5). When an area of Sphagnum becomes covered with trees the growth of the *Sphagnum* is greatly reduced because of the shade. If the forest breaks down, however,

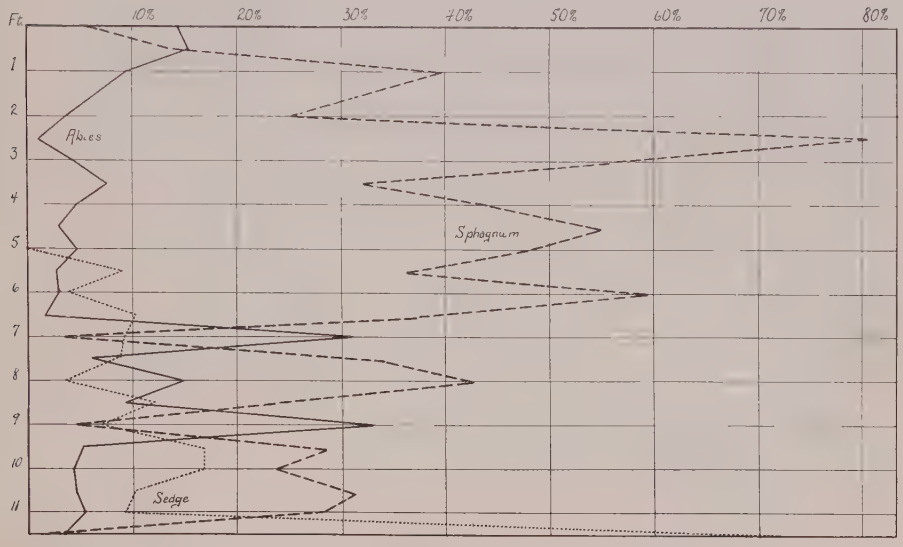

FIG. 5. Curves of Sedge, *Sphagnum* and *Abies*.

before the *Sphagnum* has been entirely killed off the latter will flourish and cover the area once more, sometimes burying the remains of the forest. Buried trees were occasionally struck by the sampler in this deposit.

The curve of fir, *Abies,* (see Fig. 5) in a general way follows that of spruce. It rises sharply to its highest points at the 9- and 7-foot levels, where it exceeds 30 per cent, and is for a short time more abundant than spruce or birch. These peaks, which coincide with spruce maxima and *Sphagnum* minima, suggest that for those two periods there existed temperature, rainfall and soil conditions much more favorable than usual to the dissemination and growth of fir trees.

Pine, *Pinus Banksiana,* was not observed as part of the bog flora, but was seen on sandy, well-drained areas some distance off. Its pollen will carry in the air for great distances, and it is quite possible that the spores found were blown in from the surrounding country.

Traces of grass were found at some of the upper levels, with a maximum of 4.5 per cent at the surface. Grasses are now found in small quantities wherever an open space occurs.

A rise in the Ericaceae seems to accompany the increase in trees which follows each *Sphagnum* peak, the highest occurring at the 4- and 2-foot levels.

The fungi were not included in the spore count because in some cases, especially where spore masses occurred, it was not possible to count them

with any degree of accuracy. Three kinds of fungus spores were found which occurred singly and could easily be recognized, and the count of them is shown in Table II. Spore "A" is spherical and reticulated, and resembles the spores of *Tilletia*. "B" is 2-celled and 4 to 5 times as long as wide. "C" is 1½ to 2 times as long as wide, flat, and curiously lobed. Their percentage was calculated on the same basis as that of the other kinds recorded. At the 2-foot level a great quantity of fungus spores and spore masses was observed, many of them in bits of wood and other debris, which suggests that at that time the destruction of the forest which fell before the *Sphagnum* maximum at 2½ feet was at its height.

A diatom, of the Centricae, was found in small quantities at nearly all levels.

The quantity of unidentified spores is low, due in part to the lack of any great variety and in part to the fact that most of the spores in this peat are easily recognized.

The curve of each plant or group of plants represented in the flora of this bog, so far as we were able to determine them, shows a large general tendency peculiar to itself upon which are imposed a series of secondary oscillations common to all.

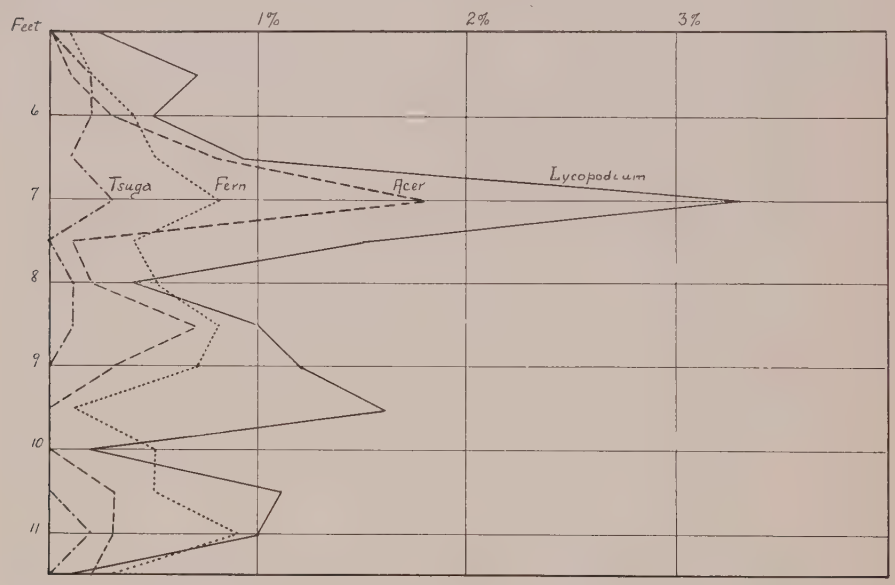

FIG. 6. Curves of *Lycopodium*, *Acer*, Fern and *Tsuga* from five-foot level to the bottom of the bog.

Spruce and birch each show 6 maxima (see Fig. 3). The 4 of these which fall between the 11- and 5-foot levels can be matched by a similar set in sedge and *Lycopodium* (see Fig. 4), and in *Acer*, ferns and *Tsuga* (see

Fig. 6). These common secondary oscillations we believe to be reflections of climatic changes, for instance, variations in temperature and rainfall.

Sedge drops from a maximum of over 70 per cent in the lowest layer to extinction at 5 feet. From the bottom to the surface, birch steadily loses ground and spruce gains. *Acer* and *Lycopodium* reach their peaks at 7 feet, Ericaceae at 4, *Sphagnum* at 2½, spruce at ½, and *Pinus,* Compositae and Gramineae (which first appear at 5½ feet) have their maxima at the surface. These large general tendencies we believe to be reflections of edaphic influences, that is, variations in the condition of the soil as to alkalinity or acidity, water content, chemical composition, degree of disintegration, etc. (Bray, '21).

Summary

Cores of peat were taken from a Quebec bog, and samples selected at 6-inch intervals were stained and mounted on slides for study. At least 1,000 spores were counted from each sample, and a record made of the number of each kind present. Curves were drawn to show the relative density of each kind of spore at each level. The curves show this to be an ocean type bog, with sedge present in the lower levels and *Sphagnum* in the upper. The curves also suggest that the bog went through an open marsh stage to one of closed forest. Each curve shows an individual trend and a set of secondary oscillations common to nearly all.

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In the spring of 1927 Mr. Copley Amory, of Washington, acting upon the recommendation of Dr. Paul Bartsch, of the National Museum, invited us to spend the summer on his estate on the Matamek River to study the flora of that district, which is little visited and which he believed held much of interest to the naturalist. Mr. Amory very kindly provided transportation for us and our equipment from Quebec; and, to further our work during the summer, he not only put the facilities of his place at our disposal, but personally took us on excursions to places which we would otherwise not have visited.

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